International Journal of Science Engineering and Advance Technology, NGCAST, IGIT, SARANG IJSEAT, Vol. 5, Issue 2 | ISSN 2321-6905 February -2017

International Journal of Science Engineering and Advance Technology

# Fault Detection of Ball Bearing Using Finite Element Analysis

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***Abstract-***During the last decade's vibration based damage detection methods have attracted the most attention due to their simplicity for implementation. This research mainly deals with detection of faults through vibration analysis by using Finite element method with the help of analysis software. There is change in mode shapes and relative natural frequencies due to fracture of ball radius. By examining these changes in ball radius and its frequencies can be identified. It has been noticed that when the ball radius decreases relative natural frequency and also there is a deviation in the mode shape. These methods provide the knowledge towards the characterization of the damage to the structure.

***Key words:*** *Bearing, Natural Frequency, Fault Detection*

## I. INTRODUCTION

Rolling element bearing sustain and place rotating shafts in machines. The term "rolling element" bearing includes equally ball bearing and rolling bearing. Rolling element bearing otherwiseknown as rolling bearing. Rolling element bearing function with a rolling action, where as plain bearings function with a sliding action. Bearing are the main part of rotating shaft. Faults in these parts can not only cause a decrease in the critical loading of the part, but can cause vibration response problem.

Fault analysis in bearing has strained a lot of attention from the science and engineering community in the last three decades. The presence of faults in a bearing, if unobserved for a longer time will lead to the failure of the system. Exploitation of the dynamic response of the member is one of the techniques, which has been generally received for fault diagnosis in different engineering system. The present chapter emphasizes the different techniques that are being used for fault analysis.

Sawalhi.n.et.al[1]has proposed signal processing techniques to detect and diagnose faults in rolling element bearings with signal processing algorithms.Sawalhi.N.et.al[2]has proposed a simulation model which will be useful for producing typical faults signals from gearbox to test new diagnostic algorithms and possibly prognostic algorithms.D.Ho.et.al[3]has investigated how bearing faults can be simulated digitally by random actuations in spacing of the excitation pulses resulting from clearance in the bearing and changing load angle experienced by each rolling element. Jerome Antoni[4]has introduced a kurtogram which is a fourth order spectral analysis to detecting and characterizing non-stationaritics in a signal or frequency.Milind Natu[5]has explicated the procedure for prediction bearing faults using FFT and by using wavelet analysis more specifically HAAR wavelet. Here the commercial software MATLAB for offline analysis.N.HarishChandra.et.al [6] has presented fault diagnosing by employing run-up signals.

## II. SIMULATIONMODELING

In commercial software CATIA a model of ball bearing were created with 10mm of ball radius, outer ring with thickness 10mm, width 30mm and cage with thickness 2mm,width 26mm as shown in Fig. 1.

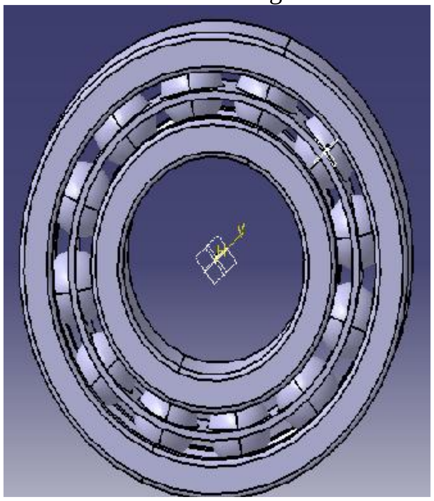

Fig 1: Simulation Model of ball bearing

## III. FINITE ELEMENT ANALYSIS METHOD

The finite element analysis was used for the frequency analysis of the ball bearing without crack and with cracked. For this reason the CATIA model of the ball bearing was imported. Then the analysis was obtained.

A three-dimensional structural SOLID187 element was selected for the analysis. Bearing were constrained for rigid boundarycondition. Models of bearing have been developed by analysis with different crack of the ball radius as sown in Fig. 2 and Fig. 3 .

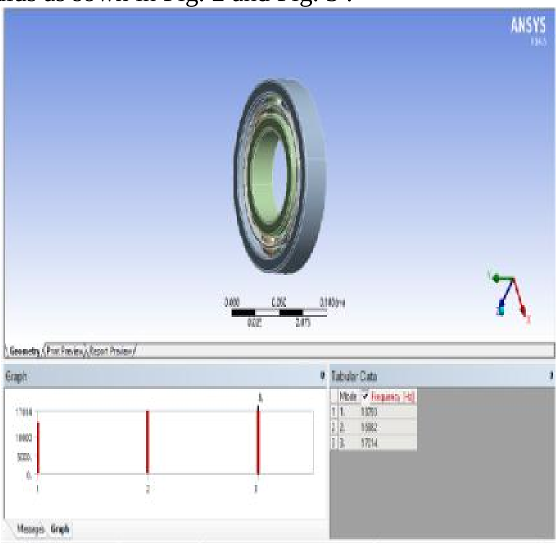


Fig: 2 Analysis of ball bearing without fault

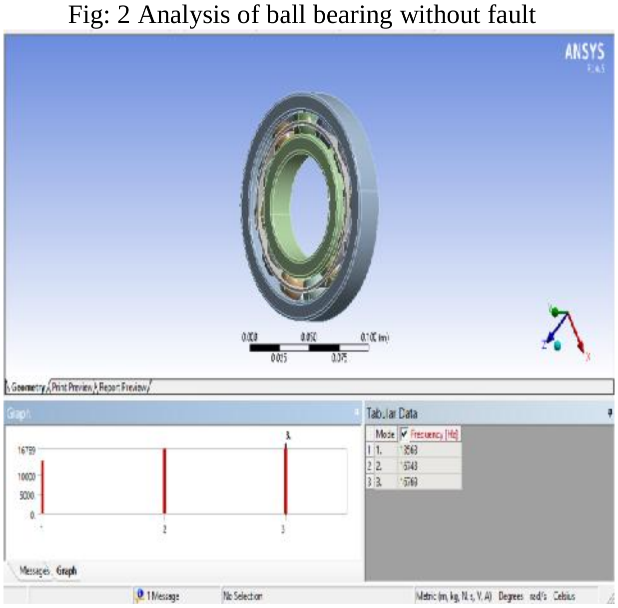


Fig: 3 Analysis of ball bearing with fault

## IV. THEORITICAL FORMULATION

The relative natural frequencies of the faulted ball bearing are calculated as follows.

$$RNF = \frac{a\ \_}{a}$$

Where,

RNF =Relative natural frequency of the faulted ball bearing

a = Natural Frequency of healthy bearing

= Natural frequency of faulted bearing

## V. TABULATION OF FREQUENCY

Table1: Tabulation of Relative natural frequency with crack diameter of first mode, second mode, third mode

| Diameter of the ball | Relative natural frequency | | |
|---|---|---|---|
| | Mode 1 | Mode 2 | Mode 3 |
| 9.99 | 0.00261 | 0.005653 | 0.000235 |
| 9.98 | 0.016675 | 0.014073 | 0.014399 |
| 9.97 | 0.002538 | 0.003120 | 0.000999 |
| 9.96 | 0.005583 | 0.007066 | 0.003115 |
| 9.95 | 0.000435 | 0.001472 | 0.003408 |
| 9.94 | 0.003843 | 0.004239 | 0.001822 |
| 9.93 | 0.005727 | 0.005947 | 0.003173 |
| 9.92 | 0.007032 | 0.006477 | 0.004760 |
| 9.91 | 0.007032 | 0.006359 | 0.004819 |

The following graphical figure can be obtained from the above table show the comparison of Relative natural frequency and different radius for mode 1, mode 2 and mode 3 respectively

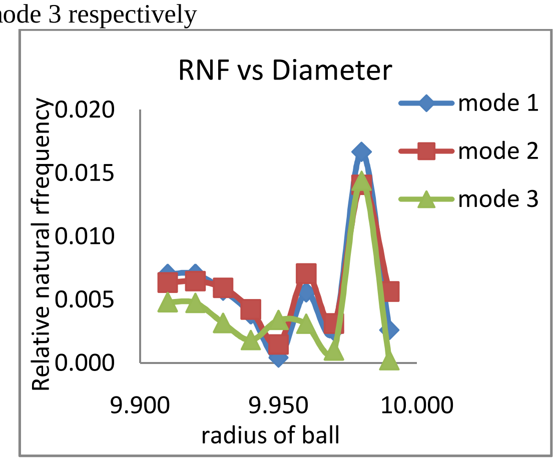


Fig 4:Plot comparing Relative natural frequency with radius for mode 1,mode 2,mode 3

## VI. CONCLUSION

From the result the following conclusions have been drawn that there is a change in natural frequencies and mode shapes of the ball bearing in the decrease of ball radius. It also observed that with a decrease in ball radius the relative natural frequency of vibration increases for first mode, second mode, and third mode of vibration.

The ball radius of a ball bearing can be analyzed by using the values of relative natural frequencies obtained from analysis with in a very short time and thereby saving a considerable amount of computational time.

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